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ABSTRACT

Cognitive mapping is used in this paper to develop a schemata which represents the knowledge domain or research and theory structure of the field of instructional technology (IST). Using the technique defined by Diekhoff and Diekhoff (1982), the primary set of concepts in instructional technology research were compared for similarity with all of the other concepts in a pairwise fashion, with the structure defined by the intercorrelation matrix of similarities. Participants were members of the Research and Theory Division of the Association for Educational Communications and Technology (AECT). Concepts were drawn from a study of the research interest of the membership; a review of titles, headings, and keywords from the Educational Communication and Technology Journal; and the Thesaurus of ERIC Descriptors. Participants were asked to rate terms in relation to their importance to the field of IST research and theory, and then to rate the degree of similarity or relatedness of 100 pairwise comparisons of randomly selected concepts. The 35 most important concepts from the first list were used to create a smaller sample of the responses from the second list, and a two-dimensional solution was plotted which shows that the IST field has a theory-into-practice orientation; however, it is suggested that a multi-dimensional analysis might produce more intellectual dimensions. A figure depicts the two dimensional plotting. (EW)

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DEVELOPING A COGNITIVE MAP OF RESEARCH AND THEORY IN INSTRUCTIONAL SYSTEMS TECHNOLOGY

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INTRODUCTION AND PURPOSE

As researchers in the field of instructional systems technology, we are often called upon to answer such queries as: What is research in instructional technology? How does it relate to existing theory in the field? We are familiar with our own research interests and the theory that supports it. But what about the big picture? Is their a model or theory of reseach in your field? While we can discourse readily on the historical development of our research, from evaluative comparison studies through attributes of media studies to information processing and intelligent systems research, can we identify and construct an appropriate schemata for research in our field? Just what is our knowledge domain?

Our knowledge domain consists of a coherent set of concepts that we use to identify our field. Just as concepts are combined by relationships to form principles, our field cannot be described by its concepts alone. Rather, our knowledge domain consists of both schemas or ideas in addition to structural knowledge. Structural knowledge describes the interrelationships between ideas in our knowledge domain. The problem is how to operationalize structural knowledge.

IST researchers usually define the domain of their own research adequately in terms of existing theory. That is, their cognitive structures for IST research and theory is comprised mostly of

research on which they have worked and its supporting theory. The individual's knowledge base enables him or her to build new knowledge strucures, make inferences, solve problems, and so on (Norman, Gentner, & Stevens, 1976).

The best way of depicting these knowledge structures is by constructing cognitive maps (Jonassen, 1987; Shavelson, 1985). Cognitive maps describe the the associative structure of constructs stored in memory. They are based upon the concept of semantic proximity of constructs, which assumes that we can represent the (semantic) proximity of ideas in memory in terms of geometric space. Cognitive maps are produced from measurements and interpreted as abstract representations of one's knowledge of subject matter content (Shavelson, 1985). The measurement of cognitive representations of subject matter structures permits us to examine the list of constructs associated with any construct, the overlap between those constructs, and the relationships between pairs based upon that overlap. The simplest method for constructing a cognitive map is to rank the degree of similarity between concepts. Statistical procedures like MDS, cluster analysis, or principal components analyze the underlying structure of the intercorrelation matrices to produce a map of the knowledge domain in which the geometric distances between each of the concepts on the map represents the semantic distance between those concepts in memory.

The purpose of this study is to generate such a map which can serve as a definition of a schemata for IST research. The study seeks to define the structure of research and theory in our field by generating a "cognitive map" of the concepts or schemas that define it. Using the technique defined by Diekhoff and Diekhoff (1982), the primary set of concepts in IST research were compared for similarity with all of the other concepts in a pairwise fashion, with the structure defined by the intercorrelation matrix of similarities. The structure was mapped to provide "the big picture".

METHOD

Participants

Participants were selected from the members of the Reseach and Theory Division (RTD) of the Association for Educational Communications and Technology. This membership is the group most concerned and involved with research and theory development in the IST field.

Instrument

The first task was to identify the most important constructs or schemas in the IST research field. Three sources were used. First, a study of research interests of the membership, recently conducted by the division, identified 107 topics in research and theory development in the field. Second, a review of titles,

headings, and keywords from the nine volumes of Educational Communications and Technology Journal generated 126 terms. Third, the ERIC thesaurus of descriptors produced 130 related terms. This list was first edited for redundance. Next the total list was edited using the following criteria for inclusion:

* generality (universality) of the term
* recognizability by researchers
* redundance (elimination of redundant or duplicative terms)
* relevance to the field of IST theory/research
* criticality to the field - importance of the concept to research
* communicability to related fields of research

After editing, the final list comprises 126 terms (see Table 1). These terms represent, according to the above criteria, the key concepts or schemas that define research and theory in IST.

Part 1: The first part of the survey listed the 50 concepts and asked the participants to rate on a 1-9 scale the importance of each term to the field of IST research and theory. The list was generated by a BASIC program which randomly selected the items from the whole list.

Part 2: A BASIC program was written to generate the second part of each survey. This part consisted of a 100 pairwise comparisons of randomly selected concepts from the final list. For each pair of concepts, the participant was asked to rate on a 1-9 scale the degree of similarity or relatedness between the terms in each pair. Item sampling was initially done from the entire list. Because a pairwise comparison of all 126 terms

would require 7875 comparisons and adequate sampling could not provide multiple responses to each cell, the 35 most important concepts were selected from the Part 1 of the responses. These concepts are underlined in Table 1. These concepts were then completely sampled, forming a 37X37 matrix.

RESULTS

Analysis

The importance ratings from Part 1 of the survey are underlined in Table 1. The responses to the pairwise comparisons of those 35 concepts were aggregated by pair in a matrix. The final cell value for each comparison consisted of the modal value. If no mode was obvious, then the means for each pair were calculated. These values for each comparison formed an 35X34 similarity matrix which was analyzed using non-metric multi-dimensional scaling (MDS).

The MDS analysis was performed using two, three and four dimensional solutions. The four-dimensional solution accounted for the greatest amount of variance, SStress=.195, R squared=.54. This was a significant improvement over the two-dimensional solution, which accounted for only 34% of the variance. The high stress, as reflective of the unaccounted variance, probably resulted from the fact that the comparisons were based upon the perceptions of several people. In order to reduce that variance, an individual differences model of ALSCAL MDS program would have

to be used. That would require several people filling completeing 1190 comparisons for the smaller matrix and 7850 comparisons for the full matrix. Stress could also be reduced by adding additonal dimensions.

The plot for the two dimensional solution is presented in Figure 1. The multiple plots for the four dimensional solution are available upon request. Interpretation of multiple dimensions is problematic. In two-dimensional space, four clusters appear to have formed: learning psychology, instructional message design, instructional design, and a types of learning. Both dimensions appear to represent a learning theory into design practice continuum. Dimension 1 represents a learning type into message design. Dimension 2 is information processing into instructional design dimension.

Discussion

It is obvious that any network description of research and theory in our field is multi-dimensional. It is a multi-faceted field. Using the two-dimensional solution, the MDS solution describes a two-dimensional theory-into-practice orientation, which describes research and theory in the field. Instructional technologists are theory-into-practice scholars for the most part. We generate applied research. An analysis of the multi-dimensional solutions may suggest more intellectual dimensions.

In order to produce complete results, much more data needs to be collected and analyzed. That logistics of such a project are far more problematic than anticipated. This has become a pilot project of sorts. If possible to complete a final project, we should be able to empirically generate a conception of our field.

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TWO DIMENTIONAL CONCEPT SCALING